Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 25 (2017) 794–805

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2016 Shanghai. 10-15 July 2016

Bringing infrastructure into pricing in road freight transportation – A measuring concept based on navigation service data

Florian Kellner[a], Andreas Otto[a], Christian Brabänder[a]*

[a] *Faculty of Business, Economics and Management Information Systems, University of Regensburg, Germany*

Abstract

Differences in road infrastructure, such as capacity, congestion, speed limits affect the productivity and the costs of short-distance freight operations. This article introduces a novel methodology that is based on navigation service data to measure the effects in terms of cost per kilometer using navigation and shipment data. The methodology is applied to five terminals of a forwarding cooperation and has been able to document significant differences in cost per kilometer across the terminals. The research results can be used by logistics service providers to better understand how productivity and thus profitability is affected by the quality of the transportation infrastructure in the particular areas they operate in. Furthermore, the insights will help these companies for better, i.e. cost-based pricing and will allow to document why and where prices need to be adapted.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: Traffic congestion; Road freight transportation; Logistics service provider; Navigation service; Short-distance freight transportation

1. The need to measure and quantify infrastructural differences in transport operations

Road infrastructure, all assets of the navigable road network (roads, traffic lights…) and the experienced traffic conditions, determines the productivity of freight transport operations, which can be measured by stops per day of a vehicle (Figliozzi 2010). If a vehicle does 13 instead of 14 stops due to poor infrastructure, the productivity decreases by 7%. Most metropolitan areas are prone to congestion. A provider of GPS assisted navigation systems, for example, ranks Stuttgart, Hamburg, Berlin, and Munich (in this order) top on a traffic index with the highest

* Corresponding author. Tel.: +49-941-943-2689; fax: +49-941-943-3187.
E-mail address: florian.kellner@ur.de

2352-1465
Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.
10.1016/j.trpro.2017.05.458

traffic problems across Germany (TomTom 2014). Freight operations, if measured in cost per kilometer, in these cities are more expensive than in rural areas. The question is how much more expensive. If the effect cannot be quantified, cost accounting and pricing cannot process it – although it may promote better decision making.

This article addresses two research questions: How can infrastructural differences be measured? How can infrastructural differences be translated into cost differences?

The ability to measure these effects is important in several situations: (1) Pricing and profitability estimations: It promotes transparent and regionally differentiated pricing of logistics services. Regions or single customers may be more expensive to serve. If infrastructural differences are neglected, cost estimations become wrong and profitability estimations as well. Thus, cost accounting will deliver poor indications. Poor pricing will follow. (2) Fair cost allocations in co-operations: Less-than-truckload forwarders run networks, where one terminal collects a shipment, which is delivered by another terminal in another area. The process is covered by internal transfer pricing, which reimburses the delivering terminal. The reimbursement should reflect infrastructural differences since they affect productivity. Correct cost allocations are a goal in itself. Furthermore, if ignored, the stability of a less-than-truckload cooperation is at risk, since the delivery operation either yields too much or too few profits, in the latter case increasing the propensity to leave the cooperation. (3) Location decisions: Real estate companies may use the method to evaluate the relative advantage of assets within logistic networks. Location decisions, for example for distribution centers, can incorporate it into their decision model.

This paper introduces a methodology to measure the effects of infrastructural differences in terms of cost per kilometer using data from navigation service providers (e.g. Bing Maps, Google Maps, INRIX, HERE, TomTom …). In a computational application the methodology is applied to five terminals of an existing, but disguised forwarding cooperation in Germany. The paper closes by listing limitations and issues for further research.

2. Literature review

Several aspects of measuring infrastructure differences and translations into cost-effects have been researched in literature and are relevant to this paper.

First, some papers discuss the addressees. Research in the fields of economy and geography views congestion costs as a loss to public welfare. Investments in projects attempting to mitigate congestion should be weighed against this loss (PPIC 2002). Schrank and Lomax (2002) estimated the costs of lost time and fuel caused by congestion at 67.5 billion USD in the USA for the year 2000. Traffic congestion also causes people to have higher stress levels (“Commuter Stress Index”; Wener et al. 2005) and has effects on health (Bigazzi and Figliozzi 2012, 2013; Levy et al. 2010). All studies expect increasing costs caused by congestion (Sarzynski et al. 2006). Most research considers the effects of congestion on the public. This paper analyzes the effects of infrastructure on transporters’ costs. Eisele and Schrank (2010), Figliozzi (2010), or Taylor et al. (2012) took the same perspective, but for different purposes than pricing.

Furthermore, data sources and data suppliers are researched. As the average travel speeds on the different road network segments may vary significantly during the day depending on the local traffic conditions, it is important to consider the time of day when the transport operations are carried out. For that reason, ‘static’ time-matrices that do not take time-varying travel times into account are not used in this research when calculating the time-based cost component of freight delivery. Information on traffic congestion can be measured using stationary sensors, induction loops, image recognition, signals from moving vehicles (“Probe Drivers”) or can be estimated with indicators such as traffic lights, etc. Lomax et al. (2011) use the data of a navigation service provider. Travel times, offered by navigation service providers exploit different techniques to observe local traffic conditions, including induction loops and signals from moving vehicles. Time-varying travel time information can be accessed in real-time. The authors regard this as a fundamental improvement (“Game Changer”; Lomax et al. 2011). This approach is adopted in this paper.

Third and most relevant to this paper, indicators to measure congestion are analyzed extensively. Rao and Rao (2012) review the use of the indicators speed, travel time / travel time delay, vehicle volume, “level of service”